WEP Warwick Evans Publishing

Transactions on Engineering and Technology Research
ISSN: 2960-1797, eISSN: 2960-2246 | Volume 4
ACEGE 2024

Research on the Application of BIM Technology in Intelligent Construction of Engineering Projects

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Abstract. Building Information Modeling (BIM) is a rapidly evolving technology that improves the efficiency and effectiveness of building design and construction processes. This study focuses on the practical application of BIM technology in engineering construction, especially in the construction of intelligent buildings. Relevant research is carried out through the intelligent management of BIM technology in all aspects of site layout and construction schedule. This paper is based on the application of BIM technology in site layout and the Internet plus application platform of BIM technology in the construction progress of actual engineering projects. This paper discusses the advantages of applying BIM technology to intelligent construction in actual engineering projects, and finds that using BIM technology to create construction sites can greatly reduce labor, time and cost. The combination of BIM platform and intelligent construction allows for closer cooperation between different engineering teams on a project, thereby improving work efficiency. By comparing the advantages and disadvantages of different BIM modeling software in intelligent construction, a construction scheme that is most suitable for engineering projects can also be obtained. The development trend of civil engineering in the future is the deep application of BIM technology in intelligent construction. In-depth research and promotion of the application of BIM in intelligent construction is of great significance to promote the progress of the entire construction industry.

Keywords: Building Information Modeling (BIM); Intelligent construction; Site layout; Engineering management; Engineering optimization.

1. Introduction

Smart construction is the use of new age technologies and digital tools to optimize the building and construction process. It covers aspects including but not limited to the use of artificial intelligence, big data analytics, Internet of Things and automation technologies to improve production efficiency, reduce construction costs, and improve engineering safety and quality [1]. The goal of smart construction is to improve and innovate traditional building and construction methods by integrating data and maximizing resource utilization. BIM technology plays an indispensable role in intelligent construction. Through BIM technology, engineering projects can achieve all aspects of digital management and intelligent monitoring of the whole life cycle. From engineering design, site layout to construction schedule, BIM technology can improve efficiency, reduce costs, and enhance project quality and safety management [2]. Therefore, in-depth research and promotion of the application of BIM technology in intelligent construction is of great significance for promoting the transformation of the construction industry to healthy green and intelligent.

The field of engineering is undergoing a wave of digital transformation, and BIM technology, as a key tool, is redefining the standards of project management and architectural design. With the rapid development of intelligent and automated technology, BIM is not limited to traditional building design and construction management, but gradually extended to the field of intelligent construction of engineering projects. In this context, this paper aims to explore the potential and possibilities of how BIM technology can be applied to intelligent construction in engineering projects. Through the application analysis of BIM in design optimization, collision detection, cost control and other aspects, it is revealed that BIM plays an important role in improving construction efficiency, reducing costs and optimizing project management [3]. Therefore, this study will deeply explore the practical

application and development trend of BIM technology in intelligent construction of engineering projects, so as to provide strong support and guidance for the digital transformation of future engineering projects.

2. Application of BIM Technology in Optimizing Site Layout in Engineering Projects

2.1. Construction Site Layout

The layout of construction facilities on the construction site is an important factor to ensure that cost and time can be controlled [4]. The layout of the construction site is to arrange the buildings, important facilities, equipment used in the construction site, transportation roads and other construction needs in space according to the layout principles [5]. The principle of its layout should be within the building red line, reasonable layout, minimizing construction land, reasonable organization of transportation routes, and avoiding mutual interference of construction work groups [6]. BIM software is used to arrange highly dangerous construction facilities on the construction site and separate the dangerous facilities from other construction facilities, which can maximize the safety index of the construction site [6, 7].

2.2. Engineering Background

This paper takes a special dormitory building project as the engineering background. The building area of the dormitory is 1732.48 square meters. The structure is a two-storey frame structure with an independent reinforced concrete foundation under the column. The planned construction period is nine months. It is necessary to select the construction scheme and construction method for this project, and prepare the construction schedule of the unit project. Through the BIM construction site layout software, the relevant engineering projects are modeled.

2.3. Site Layout Optimization Based on BIM Technology

In the construction layout, reducing unnecessary movement and reducing the frequency of material handling are the main objectives. A reasonable layout can reduce transportation costs and the distance between material transportation sites [8-10].

When using BIM technology to arrange the construction site, it is first necessary to build a three-dimensional model. Rapid modeling can be done through BIM software's own build library.

The three-dimensional model of construction site layout created by using BIM technology is shown in Fig. 1. From Fig. 1, it can be intuitively evaluated whether the location division of each construction area is reasonable and whether the layout of construction machinery and material yard is appropriate. This helps to optimize the layout scheme to meet the construction requirements of reasonable norms, green, safe and civilized. The site layout does not require any materials, and the operation is simple and easy, reducing the workload and saving a lot of time and cost [4, 9].

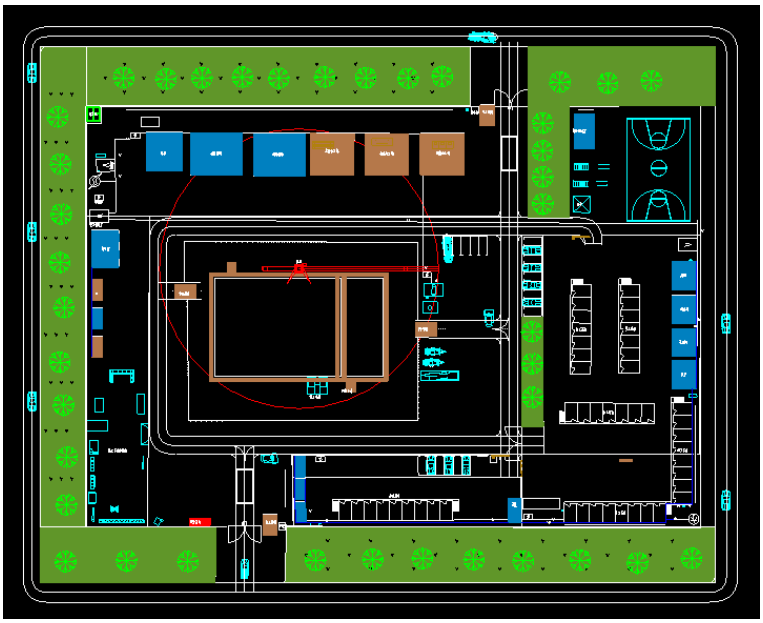

Figure 1. Three-dimensional model of construction site layout

BIM technology is used in conjunction with project planning to achieve the purpose of dynamically optimizing site layout. It can extract the type and quantity of building materials from BIM and automatically calculate the size and quantity of construction facilities using data based on BIM schedules. In the BIM-based schedule planning, the site layout can also be dynamically adjusted according to different construction stages [10].

3. Application of BIM Technology in Construction Schedule Planning in Intelligent Construction

3.1. BIM Information Processing Platform

After the relevant software is developed, the platform data can be used to see the construction progress of each construction department briefly. The BIM information processing platform is a software platform specially designed to support building information modeling (BIM) technology. Its main function is to integrate, manage and process various data and information related to construction projects. Fig. 2 shows the workflow of the BIM information processing platform. BIM information processing platform is one of the key platforms to promote the digital transformation of construction projects and improve work efficiency and project quality [11].

By using the progress control information platform based on BIM technology, real-time monitoring and visual management of building property management and building equipment can be realized [12]. BIM can realize accurate transmission and timely sharing of information between different teams [13].

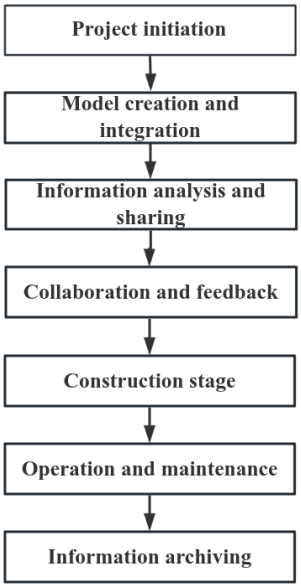

Figure 2. Working flowchart of BIM information processing platform

3.2. Dynamic Construction Schedule in Intelligent Construction

Combined with relevant software, it can complete visual simulation of site construction, understand construction progress, collect data regularly, and automatically generate completion degree of construction progress plan, which is convenient for project management personnel to supervise. The time required for each construction section is obtained by establishing corresponding tables. It can make all engineering teams work closely together to improve work efficiency [12]. Schedule control allows simultaneous changes between schedule plans and BIM models. In order to realize the dynamic optimization of the schedule plan, the schedule information of components on the model will be modified synchronously during the modification process [14].

The application of BIM technology to the construction schedule management can fundamentally reduce the delay of construction period and the defects of design quality, and improve the efficiency and quality of progress management. Through the implementation of actual projects, the advantages of BIM technology can be fully utilized, and progress management plans and schemes can be continuously optimized for comprehensive control, thus achieving better economic benefits [15].

4. Suggestions on the Application of BIM Technology in Intelligent Construction

4.1. Training and Technical Support

Provide training and technical support for the application of BIM technology to ensure that project teams and contractors can fully understand and effectively utilize BIM models. This helps to improve the modernization level of construction management and ensure the effective execution of construction schedule and site layout. At present, the mainstream software includes Revit, SketchUP, Navisworks, Guanglida Zebra progress Plan, and Guanglida BIM construction site layout software. Different BIM software has its advantages and disadvantages, as shown in Table 1 [1, 11]. It can be seen from Table 1 that it is unrealistic to apply one BIM software to various construction site layout. Therefore, in the design of the construction site, the most appropriate BIM software or a combination of multiple software should be selected according to the actual situation of the site, and the advantages of each software should be comprehensively used to achieve complementary advantages and set the best construction site scheme [1].

Table 1. Main BIM software in the market and its advantages and disadvantages

Modeling Software	Advantages	Disadvantages
Revit	Wide range of uses; Good compatibility; Quickly derive the actual engineering; quantities of the model; Easy to budget and cost control	The ability of editing and processing two-dimensional drawings is relatively weak; High requirements on hardware; Weak in handling complex surface modeling and collaborative work
Sketchup	Quickly create and edit 3D models; Huge library of plug-ins; Support real-time rendering; Allows for quick feedback and design adjustments;	Lack of professionalism; It is limited in some advanced form modeling scenarios; Built-in rendering is relatively weak.
Navisworks	Support real-time review; Intuitive and clear working interface; Easy to understand	Rendering and simulating animation require a lot of configuration and time； The tasks in a large project are heavy.
Guanglianda Zebra progress plan	Support dynamic adjustment plan; Provide professional, intelligent and easy-to-use schedule planning and management (PDCA) tools and services	High purchase and maintenance costs; Limited customer support and service.
Guanglianda BIM construction site layout software	Easy to operate; Clear interface; Focus on cost management; High market share; Good after-sales service	High price; Cannot connect to other software.

4.2. Digital Construction Schedule Management

BIM technology is used to realize real-time monitoring of construction progress. Through the establishment and update of BIM model, the establishment of real-time tracking progress control integrated system can help the project management team to supervise the construction progress. Potential schedule delays are identified and resolved in a timely manner to ensure project completion on time [3, 16].

4.3. Developing Automation of Construction Site Layout Planning

New optimization algorithms and mathematical models should be created, and a visual programming platform should be used to connect BIM and optimization algorithms [17]. The use of BIM model for virtual site layout planning can optimize the construction process and resource allocation. Through the site layout scheme simulated by BIM, the impact of different layout on construction efficiency and safety can be assessed, and potential conflicts and problems can be solved in advance [5,18].

4.4. Coordinating Communication and Real-time Data Feedback Optimization

BIM technology provides a platform for efficient collaboration among multiple participants. In the process of construction progress and site layout, BIM models are used to share and exchange data to

reduce misunderstandings and delays in information transmission and ensure the consistent understanding of construction plans and site layout schemes by all relevant parties [5, 8]. In combination with the Internet technology, real-time data is transmitted to the BIM model in time to realize the feedback of the data on the construction site, which can be used to adjust the construction schedule and site layout scheme to optimize the utilization of resources [2, 19].

5. Conclusion

This paper mainly studies the application of BIM technology in intelligent construction of engineering projects, and draws the following main conclusions:

(1) The site layout based on BIM technology does not require actual consumables, the operation is simple, the workload is reduced to a certain extent, and a lot of construction time and project costs can be saved. It can also greatly improve the safety of the site and ensure the life safety of the construction personnel

(2) Using BIM technology to run construction schedule management can make project completion more efficient. Iot + and BIM platforms can enable different engineering teams to work more closely together and improve work efficiency. Strengthening the dynamic management of construction schedule not only improves the construction efficiency but also maximizes the economic benefits.

(3) In order to design the best construction scheme, a combination of multiple BIM software is used to achieve complementary advantages, which can ensure the safety of the project and maximize the benefits of all parties. From the perspectives of improving the BIM model base of building components, optimizing the comprehensive design of BIM pipeline, strengthening the output of BIM visual drawings, and relying on BIM technology to refine the cost calculation, the use of BIM technology can make the construction process intelligent, visual and efficient development. The in-depth study of BIM models will help further optimize energy efficiency analysis in the building field in the future.

(4) Intelligent construction based on BIM technology is closer to green building design, which can further reduce resource consumption and carbon emissions. In the future, BIM will integrate more environmental data to help assess the environmental impact of construction projects and make the necessary adjustments to meet sustainable development goals.

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